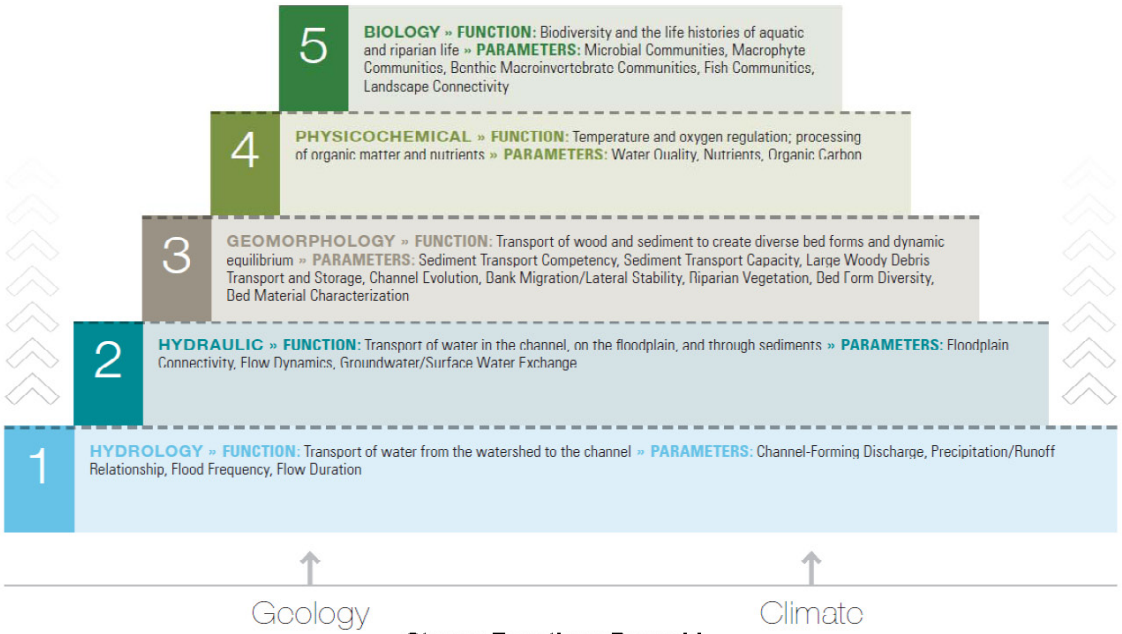
Copperwood – Orvana Resources US Corporation
Stream Mitigation Summary
MDEQ File No. 12-27-0001-P
November 13, 2012

Introduction

The following is a summary of compensatory stream impact mitigation measures proposed by the applicant (Orvana) for direct impacts from the filling of streams and the indirect impacts to the downstream reaches of those streams. This summary is intended to place the impacts in the context of the Stream Functions Pyramid hierarchy in which higher-level functions are supported by lower level functions and to supplement additional permit application information submitted on October 20 and November 9, 2012.



Stream Functions Pyramid

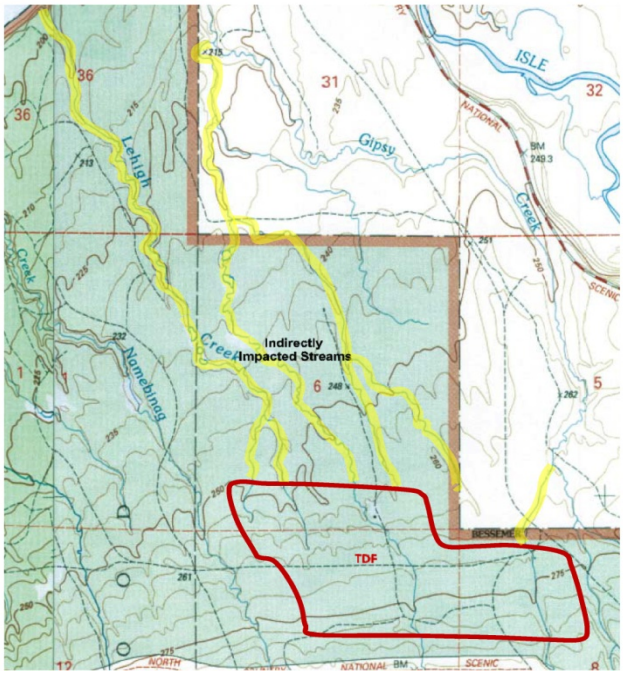
(Harman, W., R. Starr, M. Carter, K. Tweedy, M. Clemmons, K. Suggs, C. Miller. 2012. *A Function-Based Framework for Stream Assessment and Restoration Projects. US Environmental Protection Agency, Office of Wetlands, oceans, and Watersheds, Washington, DC EPA 843-K-12-006)*

Stream Impacts

The TDF is proposed to permanently displace 13,672 linear feet of ephemeral streams within the Lehigh Creek and Gipsy Creek watersheds. Surface water upstream from the TDF would be diverted around the TDF and surface water from the active and closed TDF would be discharged to downstream portions of Lehigh Creek and to the West, Middle and East Branches of Gipsy Creek. Due to constraints associated with topography, the North Country Trail right-of-way and existing wetlands, surface water cannot be diverted to match existing contributing watershed conditions. Pre- and post-TDF hydrology changes to the watersheds upstream from the diversion and for the entire watershed would be as follows:

	Upstream Watershed (sq.mi.)			Total Watershed (sq. mi.)		
Stream	**Pre-TDF**	**Post TDF**	**Change**	**Pre-TDF**	**Post TDF**	**Change**
Lehigh Creek	0.67	0.83	23.88%	0.91	1.02	+17.58%
W. Br. Gipsy Creek	0.28	0.22	-21.43%	0.60	0.54	-10.00%
M. Br. Gipsy Creek	0.30	0.19	-36.67%	0.67	0.56	-16.42%
E. Br. Gipsy Creek	0.34	0.25	26.47%	2.90	2.81	-3.10%

The length of indirectly affected ephemeral and intermittent streams is estimated to be approximately 37,700 linear feet, based on straight line measurement of the stream corridors and an average sinuosity of 1.35. The changes to hydrology will affect hydraulic and



geomorphology function parameters in that stream channels receiving additional watershed contribution are expected to increase their bank full channels slightly through degradation and transport additional sediments downstream which will likely be captured in beaver ponds while stream channels receiving less watershed contribution are expected to slightly aggrade, creating a smaller bank full channel. The amount of impact is expected to diminish as the downstream watershed increases. Physicochemical and biology parameters are expected to only be marginally impacted given the ephemeral and intermittent nature of the streams.

Impacts to the functions of the stream segments to remain upstream from the TDF are expected not to be significant given there will be no changes to hydrology or hydraulic functions and given the ephemeral nature of these streams which have very low stream functions.

Stream Mitigation: On-Site Stream Replacement

Two new streams totaling 10,500 feet in length are proposed to be constructed as surface water diversions around the east and west sides of the TDF. Using natural stream channel design, the proposed Rosgen channel types are similar to the stream channels to be impacted by the TDF. The replacement channels will have similar hydrology and have been designed with similar physical characteristics in regards to slope, bank full channel dimensions, belt width and sinuosity based on measurements made of the on-site streams and the local regional curve developed by King & MacGregor Environmental. It is anticipated that over time these replacement channels will provide most if not all of the same functions to a comparable level as the existing channels.

Stream Mitigation: On-Site Stream Restoration

The replacement of existing culverts with new culverts sized to accommodate bankfull flows is proposed in 11 locations. While most of these replacements occur on very minor tributaries, the two replacements associated with the east and west branches of Unnamed Creek will restore hydraulic and geomorphology functions to approximately 5,000 linear feet of these two streams as well as approximately 4,600 linear feet of the main branch of Unnamed Creek, which all have characteristics similar to the streams being directly impacted by the TDF. In addition approximately 1,200 linear feet of stream sediment will be directly restored by removing mine rock from the seven locations. Removal of the sediment from the streams at these seven locations will benefit the water quality, and consequently the physicochemical and biology stream functions along a total of approximately 36,200 feet of ephemeral and intermittent streams. Like the indirect impacts to the Lehigh and Gipsy Creek watersheds, physicochemical and biology function improvement is expected to be limited, however, two of these streams (Namebinag Creek and Unnamed Creek) contain the state-endangered fish species redside dace in their lower reaches. Removal of the mine rock and replacement of culverts in these two watersheds will directly benefit habitat for these fish.

Stream Mitigation: Twomile Creek Restoration

The Twomile Creek culvert replacement has been identified by the Ottawa National Forest as one of the highest priority watershed restoration projects within the Ottawa National Forest. The proposed Twomile Road culvert replacement will increase biology functions to the upstream 22 miles (116,000 linear feet) of Twomile Creek through the provision of improved fish community access. The more than three miles (16,000 linear feet) of Twomile Creek which are between County Road 527 and the Cisco Branch of the Ontonagon River will have its hydraulic function almost fully restored, providing improvements for practically every geomorphology, physicochemical and biology function parameter. Prior to final design, this stream replacement concept will require further engineering evaluation and collaborative input from regulatory agencies as well as the Ontonagon County Road Commission and the US Forest Service. This culvert replacement will be the subject of a separate application for permit to the MDEQ.